

1    **CLAIMS**

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- 3    1. A variable damper comprising;
- 4         an outer member including a magnetically conductive  
5                 sleeve;
- 6         an inner member comprising a shaft;
- 7         an electromagnet supported between the members;  
8         wherein
- 9         a chamber between the outer and inner members is at  
10                 least partially filled with magnetorheological fluid  
11                 (MRF), such that when a magnetic field is applied to  
12                 the chamber, the effective viscosity of the fluid  
13                 increases such that relative motion of the inner and  
14                 outer members is opposed;
- 15         the region between the electromagnet and the sleeve  
16                 defining a control region in which the magnetic  
17                 field is concentrated.
- 18
- 19    2. A variable damper as claimed in Claim 1 wherein, the  
20                 electromagnet is supported on the outer member.
- 21
- 22    3. A variable damper as claimed in Claim 2 wherein, the  
23                 electromagnet is supported by a plurality of struts  
24                 arranged perpendicular to the shaft.
- 25
- 26    4. A variable damper as claimed in Claim 1 wherein, the  
27                 electromagnet is supported on the inner member.
- 28
- 29    5. A variable damper as claimed in Claim 4 wherein, the  
30                 inner member comprises interconnected first and  
31                 second shaft portions between which is arranged a  
32                 housing comprising the electromagnet.
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1    6. A variable damper as claimed in any preceding Claim  
2        wherein, a diaphragm seal portion is provided at each  
3        end of the shaft to bound the chamber.

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5    7. A variable damper as claimed in Claim 6 wherein, the  
6        seal portion has an elasticity to allow the inner  
7        member to rotate in planes perpendicular to the seal  
8        portion.

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10   8. A variable damper as claimed in Claim 6 wherein, the  
11        seal portion has an elasticity to reduce at least one  
12        degree of freedom of the relative motion of the inner  
13        and outer members.

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15   9. A variable damper as claimed in any preceding Claim  
16        wherein the outer member includes a secondary housing  
17        at least at one body end surface, the/each secondary  
18        housing comprising a hollow cylindrical body  
19        including an aperture through which the shaft  
20        extends.

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22   10. A method of variably damping relative motion between  
23        an outer member including a magnetically conductive  
24        sleeve and an inner member, comprising the steps:  
25

- 26        (a) supporting an electromagnet between the members  
27            such that a flow path exists between the  
28            electromagnet and the sleeve;  
29        (b) placing a magnetorheological fluid between the  
30            members;  
31        (c) applying a minimal magnetic field to the  
32            electromagnet;  
33        (d) increasing the field in the flow path; and

- 1       (e) increasing viscosity of the fluid to thereby  
2              oppose relative motion of the membranes and  
3              create damping with minimal off-state.
- 4
- 5       11. A vibration control system for reducing vibrations  
6              between a first and a second element, a  
7              magnetorheological fluid variable damper being  
8              located between the elements and operated to cause  
9              active damping between the elements, wherein the  
10             system has a relative figure of merit of less than  
11             0.83.
- 12
- 13       12. A vibration control system as claimed in Claim 11  
14             wherein the relative figure of merit is less than or  
15             equal to 0.5.
- 16
- 17       13. A vibration control system as claimed in Claim 11 or  
18             Claim 12 wherein the magnetorheological fluid  
19             variable damper is according to anyone of Claims 1 to  
20             9.
- 21
- 22       14. A vibration control system as claimed in any one of  
23             Claims 11 to 13 wherein the shaft is connected to the  
24             first element and the housing is connected to the  
25             second element; and the system further comprises a  
26             spring located between elements; first and second  
27             accelerometers located between the damper and the  
28             respective first and second elements; and a control  
29             unit for inputting accelerometer values and  
30             outputting a small electric current to the  
31             electromagnet, to cause active damping between the  
32             first and second elements.
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1 15. A vibration control system as claimed in Claim 13 or  
2 wherein the inner and outer members of the  
3 damper are configured to be suitable for attachment  
4 to components of a device, such that the application  
5 of relative forces between the components results in  
6 corresponding forces being applied to the inner and  
7 outer members of the damper.

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9 16. A vibration control system as claimed in Claim 15  
10 wherein, a parasitic power generator is incorporated  
11 within or on the device to provide the electric  
12 current that drives the electromagnet.

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14 17. A vibration control system as claimed in Claim 15 or  
15 wherein, the device comprises at least one  
16 sensor that detects a variable, the value of which  
17 can be used to determine a desire amount of electric  
18 current to be applied to the electromagnetic coil.

19

20 18. A vibration control system as claimed in Claim 17  
21 wherein an intelligent control unit (ICU) is  
22 provided, which is capable of receiving input signals  
23 from the sensors and outputting command signals to  
24 the damper, the command signals being derived from an  
25 algorithm used to determine a desired relationship  
26 between the input signals and the damping required.

27

28 19. A vibration control system as claimed in any one of  
29 Claims 15 to 18 wherein the device is a snowboard,  
30 one of the outer member and inner member of the  
31 damper is attached to the surface board, and the  
32 other of the inner member an outer member is attached  
33 to a raised portion formed on the board.

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2 20. A vibration control system as claimed in Claim 19  
3 wherein a plurality of dampers are attached to the  
4 board.

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6 21. A vibration control system as claimed in Claim 19 or  
7 Claim 20 wherein, torsion forks are provided on the  
8 board and connected to the inner member of the device  
9 to enable control of torsional stiffness of the  
10 board.

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12 22. A vibration control system as claimed in any one of  
13 Claims 15 to 18 wherein the device of a golf club,  
14 one of the outer member and inner member of the  
15 damper is attached to the shaft of the club, and the  
16 other of the inner member and outer member is  
17 attached to or forms the grip of the club.

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19 23. A vibration control system as claimed in any one of  
20 Claims 15 to 18 wherein the device is a handle which  
21 is a component of a machine, wherein the machine is  
22 selected from a group comprising: a tennis racket,  
23 polo mallet, sports implement, a household tool, a  
24 power drill, a bicycle, a motorcycle, or the like.

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26 24. A vibration control system as claimed in any one of  
27 Claims 15 to 18 wherein, the device is an engine  
28 mount, pump mount, or the like.

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